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F Report

R-87-10-0225

Saskatchewan Soil Survey

Conducted by
Saskatchewan Institute of Pedology
University of Saskatchewan

Funded by the Agriculture Development Fund

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SASKATCHEWAN SOIL SURVEY

PROJECT R-87-10-0225

FINAL REPORT

TO

SASKATCHEWAN
AGRICULTURE DEVELOPMENT FUND

BY

Saskatchewan Institute of Pedology
University of Saskatchewan
Saskatoon, Saskatchewan

February 28, 1990

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Final Report (1987-90)
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EXECUTIVE SUMMARY

Abstract

The Saskatchewan Soil Survey Project undertook to develop our soil resource data base and associated conservation interpretive capacity for selected areas of Saskatchewan in order to: facilitate the assessment of the nature and extent of soil degradation; facilitate the extrapolation of research results; determine the extent, location and characteristics of Solonetzic and saline soils; provide agricultural capability for marginal soils; and provide maps and reports on an R.M. basis. The project has markedly accelerated the soil mapping program as evidenced by the completion of 49 R.M.'s, including preliminary interpretive reports. Interpretations with respect to extent, degree and cause of salinity; susceptibility to wind and water erosion; variability of surface pH and organic matter content; and others, are of benefit to agencies with soil conservation, extension, and other programs, as well as to farmers and other individuals. Research supported by the project has furthered our knowledge of the variability of pH and organic matter in cultivated soils, of means of more accurately assessing wind erosion susceptibility, of the feasibility of ameleorating Solonetzic soils by deep tillage, and the response of acid soils to liming.

Summary

Soil surveys have been completed for 20 rural municipalities in northeastern Saskatchewan and 29 rural municipalities in western and southwestern Saskatchewan with the assistance of this project. Preliminary reports are now available for 32 of these municipalities and will be available for the remaining 17 municipalities by May 1, 1990. These reports contain a soil map and interpretive tables that enable the user to evaluate the agricultural capability, productivity, salinity, drainage, irrigation suitability, wind and water erosion susceptibility, pH and acidity, stones, and sand and gravel potential for any area of land in the municipality. Conversion of the maps to digital form is continuing and the capability to produce interpretive maps on a request basis is being developed.

Final reports were published for 11 municipalities, and have been prepared for an additional 27 municipalities. These reports present a full description of soils, surficial geology and groundwater resources, and agriculturally-oriented interpretations presented in the form of multi-colored interpretive maps. Numerous diagrams and color photographs supplement the text.

Studies on organic matter and surface pH variability of cultivated soils are continuing, with the information being published in map format, in an attempt to provide farmers and researchers with better information on which to base recommendations for herbicide usage.

Research was continued on the effect of liming acid soils in Saskatchewan. A bulletin is being published, based on this research, that outlines some recommendations for liming soils in Saskatchewan.

A deep plowing research project continued throughout the length of this agreement. A bulletin has been published that discusses the benefits, as well as the deleterious effects of deep tillage on Saskatchewan soils.

BACKGROUND AND OBJECTIVES

The Saskatchewan Soil Survey embarked on a program, in 1958, to provide "semi-detailed" soil survey information for the agricultural area of Saskatchewan based on the national system of soil classification. The Saskatchewan Institute of Pedology (SIP) has a commitment to complete this resurvey of the agricultural area of the province and to research the properties of the soils encountered to facilitate the interpretation of their performance and quality changes. This is a cooperative program which is funded by Agriculture Canada/Research Branch, University of Saskatchewan and by the Province of Saskatchewan through the Agricultural Development Fund. In addition, in 1987 and 1988 the resurvey component of this program was accelerated through support from the Canada/Saskatchewan subsidiary agreement for agriculture under the Economic and Regional Development Agreement (ERDA). In 1989 this additional support was continued through the Canada/Saskatchewan agreements under the National Soil Conservation Program (NSCP). The objectives of the project were:

a) Soil Survey

To develop our soil resource data base and associated soil conservation interpretive capacity for selected areas in Saskatchewan, in order to facilitate the assessment of the nature and distribution of soil degradation, and to facilitate the extrapolation of results from research, that is aimed at developing effective remedial programs, to the agricultural community. To determine the extent, location and characteristics of Solonetzic and saline soils and to assess the feasibility of amelioration. To provide agricultural capability ratings for marginal soils. And, to provide both preliminary and final reports and maps on a rural municipality basis showing soils and many important interpretations. To distribute the maps and reports to government, private agencies and farmers to assist them in decision-making processes regrading use of these lands. In particular, this area included the R.M.'s of Prince Albert (461), Birch Hills (460), St. Louis (431), Invergordon (430), Fish Creek (402), Hoodoo (401), Three Lakes (400), Lake Lenore (399), Pleasantdale (398), Barrier Valley (397), Grant (372), Bayne (371), Humboldt (370), St. Peter (369), Spalding (368), and Ponass Lake (367) in northeastern Saskatchewan and the R.M.'s of Stonehenge (73), Wood River (74), Pinto Creek (75), Auvergne (76) Wise Creek (77), Grassy Creek (78), Arlington (79), Sutton (103), Gravelbourg (104), Glen Bain (105), Whiska Creek (106), Lac Pelletier (107), Bone Creek (108), Carmichael (109), Piapot (110), Maple Creek (111), Webb (138), Gull Lake (139), and Big Stick (141) in western Saskatchewan.

b) Soil Correlation

To ensure soil survey in Saskatchewan applies consistent mapping and interpretive standards throughout the province; that these standards meet national requirements and that map quality/reliability requirements are met.

c) Data Analysis and Interpretation

To implement an automated system of data analysis and map production, to facilitate the transfer of soil related data to the agricultural community by 1) compiling an electronic data base of pertinent inventory and related data, 2) developing an automated map analysis and production system to facilitate the production of interpretive maps and 3) integrating soil data with land use, crop yield and climatic data in order to provide the information necessary to deal with complex endeavours such as the development of production ratings, erosion indices, etc.

EXPERIMENTAL METHODS

Project specifications (map area, objectives of survey, mapping specifications) are developed and approved by the Technical Committee of the SIP at the time of application for the grant. Subsequently, detailed plans for the survey and associated research were developed, resource information assembled, and aerial photographs obtained. Aerial photographs were examined to determine probable soil boundaries (pre-typing) prior to commencement of the field surveys. Field operations included: orientation; evaluation of pre-typing; conduct of transects; mapping soil distribution within each township of each RM by traversing all available roads, making soil inspections at irregular intervals and plotting soil boundaries on airphoto field sheets; sampling and analysis of selected sites along transects as well as complete characterization of several soil profiles, using the field and headquarters laboratories. Office-based operations included: preparation of a soil map by transferring all polygon boundaries from the airphoto field sheets to suitable base maps, followed by the addition of symbols to depict soils information; compilation and digitization of soil maps and extended legends; evaluation of research results and incorporation, as required, into various interpretation procedures; preparation and distribution of a preliminary report for each RM within one year of initiation of the survey; and submission of material to the Cartographic Section of the Land Resource Research Institute (LRRC) in Ottawa, for publication of final reports. As they were printed, reports were distributed and their utility evaluated.

Preparation of relational databases involved the conversion of soil lines from maps into digital form and the compilation of an attribute file or table, for each map, in which each soil polygon was characterized in terms of its basic soil characteristics (slope, texture, drainage, etc.) and other related data. Automated data and map analysis capabilities rested with LRRC in Ottawa and the production of interpretive maps such as the extent and distribution of acid soils rested with them. However, local capabilities have been developed under this program and are being expanded so that production of interpretive maps will be feasible locally.

Research projects associated with the soil survey program were carried out by soil survey staff in addition to their field mapping activities. The objectives of these projects were established on the basis of requirements for data needed to augment soil survey information with respect to interpretations. These research projects often involved graduate students utilizing facilities of the University of Saskatchewan in general, and the Department of Soil Science in particular.

RESULTS AND DISCUSSION

1. Soil Surveys in Northeastern Saskatchewan.

A total of 3,473,190 acres were mapped in the R.M.'s of Prince Albert (461), St. Louis (431), Invergordon (430), Fish Creek (402), Hoodoo (401), Three Lakes (400), Lake Lenore (399), Pleasantdale (398), Barrier Valley (397), Grant (372), Bayne (371), Humboldt (370), St. Peter (369), Spalding (368), Ponass Lake (367), Colonsay (342), Viscount (341), Wolverine (340), Leroy (339), and Lakeside (338) (see Appendix I for year by year activities). The R.M.'s of Colonsay, Viscount, Wolverine, Leroy and Lakeside were in addition to those outlined in the contract. The R.M. of Birch Hills was not included in the mapping program as it had been mapped in 1986. During the mapping program a total of 268 transects, each with 12 examinations were conducted in the area. The surface soil at each site was sampled for pH analysis and every third site for organic carbon analysis. In addition, 91 profiles were sampled for complete analysis. Maps, extended legends and preliminary reports were prepared and distributed for all R.M.'s mapped in 1987 and 1988 and are presently being prepared for those R.M.'s mapped in 1989. These will be ready for distribution by May 1, 1990. They are distributed to R.M. offices, extension agrologists, provincial land representatives, and rural assessment and PFRA personnel. As well, they are made available to other agencies and individuals on request. To date, 375 of these reports have been distributed. In addition, final reports for several R.M.'s, mapped previously in

the Melville map sheet, were printed and distributed during the extent of this contract (see 5a below). Three additional reports covering the remaining 13 R.M.'s in the Melville map sheet are presently in Cartography in Ottawa being readied for publication (see 5a below). As well, preliminary maps and reports were prepared and distributed for seven R.M.'s previously mapped in the Melville-Weyburn map sheets but not included in published reports. These include the R.M.'s of Maryfield (91), Walpole (92), Wawken (93), Hazelwood (94), Golden West (95), Fillmore (96) and Wellington (97). A special research project investigating the variability of surface pH and organic matter levels was initiated and is continuing in the survey area. This data is used to improve interpretations on surface pH in present reports and will be used to generate interpretations for organic matter levels in future reports.

2. Soil Surveys in Western Saskatchewan.

A total of 6,601,710 acres were mapped in the R.M.'s of Stonehenge (73), Wood River (74), Pinto Creek (75), Auvergne (76) Wise Creek (77), Grassy Creek (78), Arlington (79), Sutton (103), Gravelbourg (104), Glen Bain (105), Whiska Creek (106), Lac Pelletier (107), Bone Creek (108), Carmichael (109), Webb (138), Gull Lake (139), Big Stick (141), Enterprise (142), Riverside (168), Pittville (169), Fox Valley (171), Miry Creek (229), Clintworth (230), Happyland (231), Deer Forks (232), Prairiedale (321), Antelope Park (322), Progress (351) and Heart's Hill (352) (see Appendix I for year by year activities). The R.M.'s of Webb, Enterprise, Riverside, Pittville, Fox Valley, Miry Creek, Clintworth, Happyland, Deer Forks, Prairiedale, Antelope Park, Progress and Heart's Hill were in addition to those outlined in the contract. The R.M.'S of Piapot and Maple Creek were replaced in the mapping program by some of the additional R.M.'s listed above, for the sake of a more efficient mapping program. During the mapping program a total of 370 transects, each with 12 examinations were conducted in this area. The surface soil at each site was sampled for pH analysis and every fourth site for organic carbon analysis. In addition, 53 profiles were sampled for complete analysis. Maps, extended legends and preliminary reports have been prepared and distributed for all R.M.'s mapped in 1987 and 1988, and are presently being prepared for those R.M.'s mapped in 1989. These will be ready for distribution by May 1, 1990. They are distributed to R.M. offices, extension agrologists, provincial land representatives, and rural assessment and PFRA personnel. As well, they are made available to other agencies and individuals on request. To date, 1,423 of these reports have been distributed. In addition, a final report for three R.M.'s mapped previously in the Battleford map sheet, was printed and distributed during the extent of this contract (see 5a below). Final reports

for a number of additional R.M. blocks are in various stages of preparation (see 5a below). A special research project investigating the variability of surface pH and organic matter levels was initiated and is continuing in the survey area. This data will be combined with data being collected in eastern Saskatchewan and used to improve interpretations on surface pH and organic matter levels in future reports. As well, a cooperative project was carried out with Lands Branch of Saskatchewan Agriculture to develop soil-based interpretations for range management.

3. Attribute Files for the Soil Landscape Map of Saskatchewan.

The Soil Landscape Map project involved soils and landscape information for the whole province at a scale of 1:1,000,000. The map and extended legend was updated to incorporate information gathered by new soil surveys. In addition, new attribute files were prepared that include the soil name and chemical and physical characteristics.

4. Attribute Files for 1:125,000 Soil Maps.

Attribute files are being prepared for all soil surveys carried out between 1958 and 1975. Files containing basic characteristics such as polygon number, slope class, map unit, and texture were completed. The map unit file, soil names file, and soil layer file have also been completed and are being updated on a continuing basis. All files are compatible with the Arc/Info G.I.S. Cartographic files being developed by LRRC in Ottawa.

5. Soil Survey Publications and Extension Activities.

a) Comprehensive Soil Survey Reports.

During the period of this agreement the following soil survey reports were published and distributed:

Soils of the Silverwood (123), Kingsley (124), Willowdale (153), Elcapo (154) Rural Municipalities, Saskatchewan, SIP Publ. No. S206, 1987.

Soils of the Moosomin (121), Martin (122), Rocanville (151), Spy Hill (152) Rural Municipalities, Saskatchewan, SIP Publ. No. S207, 1987.

Soils of the Reford (379), Tramping Lake (380), Buffalo (409) Rural Municipalities, Saskatchewan, SIP Publ. No. S211, 1989.

Extension meetings were held to introduce these reports, as well as those for the rural municipalities of Montmartre and

Francis which were printed earlier. These meetings involved Extension Agrologists, personnel from the R.M. offices and farmers in each R.M.

Final reports for the following R.M. blocks are in various stages of preparation: 1) R.M.'s 381, 382, 410, 411 - SIP Publ. No. S212; 2) R.M.'s 440, 442, 471, 472 - SIP Publ. No. S213; 3) R.M.'s 439, 469, 470 - SIP Publ. No. S214; 4) R.M.'s 437, 438, 468 - SIP Publ. No. S215; 5) R.M.'s 377, 378, 408 - SIP Publ. No. S216; 6) R.M.'s 317, 318, 347 - SIP Publ. No. S217; 7) R.M.'s 319, 349, 350 - SIP Publ. No. S218; 8) R.M.'s 321, 322, 351, 352 - SIP Publ. No. S219. Some of these rural municipalities were mapped prior to the start of this project. The first three of these reports (S212, S213, S214) have been submitted to Cartography in Ottawa and will be published as funds become available. The remainder will be submitted in 1990 and 1991 and will be published over the next several years.

b) Preliminary Maps and Reports.

Preliminary maps and reports have been prepared for all R.M.'s mapped in 1987 and 1988. Maps and reports are presently being prepared for those R.M.'s mapped in 1989 and will be ready for distribution by May 1, 1990. These reports and maps will be distributed to Extension Agrologists, municipal offices, Agriculture Canada Research Stations, Lands Branch, Assessment Agency, Soils and Crops Specialists and others. To date, approximately 2000 of these reports have been distributed in the province.

c) Extension Bulletins.

i) pH of Saskatchewan Soils

The pH map of Saskatchewan was revised using new information and reprinted in a new bulletin entitled "pH of Saskatchewan Soils", SIP Publ. No. M84. Copies were distributed to all Extension Agrologists and are available upon request.

ii) Deep Tillage of Solonetzic Soils

An information sheet "Deep Tillage of Solonetzic Soils", SIP Publ. No. M88, was prepared to advise farmers and extension workers on the benefits and hazards of deep plowing and ripping of problem soils.

6. Tillage Practices as Methods of Improving Solonetzic Soils.

A project to test the effects of deep plowing and deep ripping on Solonetzic soils in the Dark Brown and Brown Soil Zones was

initiated in 1986, supported to a large extent by Canada ERDA through PFRA. Sites were selected at Kerrobert and Weyburn and sampled in detail to characterize the soils before plowing. Deep tillage operations at the Kerrobert and Weyburn sites were completed in the fall of 1987. At each site, nine plots were established; three were deep plowed, three were deep ripped and three were left undisturbed as control plots. Soil chemical and physical properties and their change with time, as well as yields were monitored closely over the past three years. In addition, neutron tubes installed at each site allowed monitoring of soil moisture changes. The results of this research were utilized in the preparation of the bulletin mentioned in 5cii above.

7. Measuring Wind Erosion.

A study, supported in part with funds from LRRC Ottawa, to measure actual wind erosion on a wide range of soils in southwestern and northeastern Saskatchewan was carried out over the three years of the contract. The objectives of the research were to improve the erodibility classification of Saskatchewan soils, to determine the fractions of the soil that actually move by wind and are lost from the field, and to measure changes in aggregate structure of surface soils over the course of the year. The results of this study have been utilized to improve the interpretation for susceptibility to wind erosion in current and future soil survey reports.

8. Soil Quality and Soil Genesis and their Effect on Agricultural Soils.

There were a number of studies, undertaken during the course of this contract, involving graduate students working under the direction of Drs. D.W. Anderson and A.R. Mermut. One study investigated the effect of aspen invasion of grasslands on soil properties, where sites of varying leaching potential were examined. A second study investigated the movement of carbonates and iron in sandy soils and particularly the influence of hydrology on nutrient movement and cycling. A third study investigated the evolution of Solonetzic soils formed in lacustrine sediments. Of particular interest was how certain chemical, mineralogical, and physical properties interact with morphology during the development, stabilization and deterioration of these soils. A fourth study investigated the use of pedogenic carbonate pendants (coatings of reprecipitated carbonate on the underside of rocks) to evaluate fluctuations in soil temperatures over the last 8,000 years. A fifth study investigated ways of quantifying calcium-carbonates when using thin section analysis in soil genesis studies.

9. Variability of Organic Matter in Cultivated Soils.

Many herbicide recommendations require knowledge of organic matter levels in soils. To increase our knowledge of organic matter levels and variability throughout the landscape, a detailed sampling program was initiated and is continuing, to determine organic matter levels and to establish their relation to slope position within cultivated fields. This information is being included in preliminary soil reports and in computerized reports.

10. Soil Survey Laboratory

The soil survey laboratory continued to work at full capacity to produce chemical and physical analysis required for the survey program and associated research. The following is a list of the analysis conducted over the length of this program and the number of soil samples in each category:

Conductivity and soluble salts	4515
pH	12980
Organic Matter	8300
Carbonates	5610
Total Nitrogen	700
Exchangeable Cations	4470
Textural Analysis	4635
Hygroscopic Moisture	8500
1/3 and 15 Atm. Moisture	1000

CONCLUSIONS AND IMPACT

The acceleration of the soil survey program in Saskatchewan was very pronounced. The combined support of the Agriculture Development Fund, Agriculture Canada, ERDA and now NSCP, has resulted in a yearly inventory rate of approximately 3.5 million acres. This advances the date when all areas of agricultural Saskatchewan will have an adequate soil resource inventory upon which technology transfer for crop production, soil conservation, agricultural sustainability, land appraisal, and many other aspects can be based.

As new surveys are completed (approximately 16 municipalities per year) soil and interpretive maps are prepared that address immediate problems such as soil salinity, soil pH, agricultural capability, deep tillage and others. The following discussion highlights selected features of the total soil survey program.

Soil Salinity Interpretations

The soil salinity section, along with the geology and groundwater resources sections of final reports present information on the severity of soil salinity and on groundwater and its movement through water-bearing stratigraphic units in the map area, respectively. Research has shown that the major cause of soil salinity is the movement of groundwater to the soil surface. These report sections are complimentary in that the information on groundwater movement is utilized to interpret the potential cause of soil salinity within the map areas. With this background information, the soil salinity section provides management recommendations regarding what can be done to control soil salinity. Additionally, these sections provide a valuable framework from which additional soil salinity investigations or exploration for supplies of groundwater can proceed. These soil reports represent the only source of this integrated information available in a systematic and easily available form.

Preliminary Reports

The soil survey has a commitment to have a map, report, and table of interpretations for a municipality in the users hands one year after the survey is initiated. Landowners, municipal offices, and Extension Agrologists are notified by letter that a soil survey is to take place and that 12 months later a report will be available with the results of the survey. This quick availability of the information has greatly increased its use. In addition, as this information is made available in computer accessible form, its usefulness will further increase.

Soil pH and Liming

A bulletin has been prepared that includes a map showing the surface pH of Saskatchewan soils. Initially the map was prepared to delineate areas of low pH that could benefit from liming. This information is now been supplemented with another bulletin that discusses the liming of acid soils. This information will facilitate farm decisions with respect to the economics of liming these soils. An additional use of the pH map has been by chemical companies interested in the distribution of soils with a surface pH in the alkaline range (pH 7.5 or greater). The pH of the surface soil is critical in determining the length of time certain herbicides remain active in the soil and in determining the residual affect on sensitive crops in subsequent years.

Deep Plowing Solonetzic Soils

Many farmers have expressed an interest in deep plowing some or all of their problem soils in an attempt to increase production. Before they spend large amounts of money to rip or plow, they require the best available information on the subject. Research has been carried out to address this and a bulletin has been prepared that discusses the benefits and also the deleterious effects of deep tillage on Saskatchewan soils.

Appendix I

Mapping Progress

1987

RM	NAME	TRAN-SECTS	TOWN-SHIPS	TOTAL ACRES	ACRES MAPPED
73	Stonehenge	14	12	248,690	248,690
74	Wood River	14	9	204,060	204,060
79	Arlington	6	9	207,360	207,360
103	Sutton*	4	9	207,360	138,240
104	Gravelbourgh*	7	9	207,380	138,240
105	Glen Bain*	16	9	207,370	138,240
108	Bone Creek	13	9	207,390	207,390
109	Carmichael	13	9	207,390	207,390
138	Webb	22	12	285,910	285,910
139	Gull Lake	15	9	207,350	207,350
372	Grant*	9	7.6	175,540	65,280
401	Hoodoo	12	9	207,370	207,370
402	Fish Creek*	6	6.7	153,450	83,200
430	Invergordon	15	9.3	214,840	214,840
431	St. Louis	19	9.1	209,250	209,250
461	Prince Albert	30	11.4	261,540	261,540
	TOTAL	215	149.1	3,412,250	3,024,350

1988

RM	NAME	TRAN-SECTS	TOWN-SHIPS	TOTAL ACRES	ACRES MAPPED
75	Pinto Creek	13	9	207,380	207,380
76	Auvergne	13	9	207,370	207,370
77	Wise Creek	13	9	207,360	207,360
78	Grassy Creek	8	9	207,350	207,350
106	Whiska Creek*	15	9	207,330	138,240
107	Lac Pelletier*	14	9	207,380	138,240
321	Prairiedale	13	6	138,240	138,240
322	Antelope Park	5	6	153,230	153,230
351	Progress	4	9	207,380	207,380
352	Heart's Hill	5	9	198,000	198,000
369	St. Peter	15	9	207,360	207,360
370	Humboldt	24	9	207,370	207,370
371	Bayne	33	9	207,330	207,370
397	Barrier Valley*	3	9	207,340	69,120
398	Pleasantdale**	0	9	207,380	69,120
399	Lake Lenore	10	9	207,740	207,740
400	Three Lakes	22	9.4	216,150	216,150
	TOTAL	210	147.4	3,401,690	3,263,460

Appendix I (cont'd)

1989

RM	NAME	TRAN-SECTS	TOWN-SHIPS	TOTAL ACRES	ACRES MAPPED
141	Bigstick	3	9	207,360	207,360
142	Enterprise	4	10.7	245,800	245,800
168	Riverside	0	14.3	325,850	325,850
169	Pittville	0	13.5	311,040	311,040
171	Fox Valley	4	13.5	311,040	311,040
229	Miry Creek	1	13	299,080	299,080
230	Clintworth	12	14.3	347,140	347,140
231	Happyland	15	13.5	309,500	309,500
232	Deer Forks	2	8.3	182,780	182,780
338	Lakeside	11	9	207,380	207,380
339	Leroy	9	9	207,340	207,340
340	Wolverine	0	9	207,350	207,350
341	Viscount*	0	9.1	210,710	149,270
342	Colonsay*	0	6.2	143,880	61,440
367	Ponass Lake*	13	9.1	210,410	69,120
368	Spalding	22	9	207,360	207,360
398	Pleasantdale***	15	9	207,380	138,240
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	TOTAL	111	179.5	4,141,400	3,787,090

* partial RM mapped - remainder mapped during a previous survey
** three townships mapped in 1988
*** six townships mapped in 1989

Appendix II

Publications and Presentations

Preliminary Reports

1. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Webb, No. 138, March 1, 1988.

2. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Stonehenge, No. 73, April 1, 1988.

3. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Wood River, No. 74, April 1, 1988.

4. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Pinto Creek, No. 75, April 1, 1988.

5. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Arlington, No. 79, April 1, 1988.

6. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Sutton, No. 103, April 1, 1988.

7. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Gravelbourg, No. 104, April 1, 1988.

8. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Glen Bain, No. 105, April 1, 1988.

9. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Bone Creek, No. 108, April 1, 1988.

10. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Carmichael, No. 109, April 1, 1988.

11. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Gull Lake, No. 139, April 1, 1988.

Appendix II (cont'd)

12. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Grant, No. 372, May 1, 1988.

13. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Hoodoo, No. 401, May 1, 1988.

14. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Fish Creek, No. 402, May 1, 1988.

15. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Invergordon, No. 430, May 1, 1988.

16. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of St. Louis, No. 431, May 1, 1988.

17. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Prince Albert, No. 461, May 1, 1988.

18. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Auvergne, No. 76, May 1, 1989.

19. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Wise Creek, No. 77, May 1, 1989.

20. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Grassy Creek, No. 78, May 1, 1989.

21. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Maryfield, No. 91, May 1, 1989.

22. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Walpole, No. 92, May 1, 1989.

23. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Wawken, No. 93, May 1, 1989.

Appendix II (cont'd)

24. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Hazelwood, No. 94, May 1, 1989.

25. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Golden West, No. 95, May 1, 1989.

26. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Fillmore, No. 96, May 1, 1989.

27. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Wellington, No. 97, May 1, 1989.

28. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Whiska Creek, No. 106, May 1, 1989.

29. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Lac Pelletier, No. 107, May 1, 1989.

30. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Prairiedale, No. 321, May 1, 1989.

31. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Antelope Park, No. 322, May 1, 1989.

32. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Progress, No. 351, May 1, 1989.

33. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of Heart's Hill, No. 352, May 1, 1989.

34. Staff, Saskatchewan Soil Survey. Preliminary Soil Map and Report for the Rural Municipality of St. Peter, No. 369, May 1, 1989.

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